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PHILOSOPHICAL TRANSACTIONS.

IX. *Abstract of Observations on a diurnal Variation of the Barometer between the Tropics. By J. Horsburgh, Esq. In a Letter to Henry Cavendish, Esq. F. R. S.*

Read March 14, 1805.

SIR,

Bombay, April 20, 1804.

WHEN I was in London at the conclusion of the year 1801, I had the pleasure of being introduced to you by my friend Mr. DALRYMPLE, at which time he presented you with some sheets of meteorological observations, with barometer and thermometer, made by me in India, and during a passage from India to England.

Being of opinion that few registers of the barometer are kept at sea, especially in low latitudes, I have been induced to continue my observations since I left England, judging that, even if they were found to be of no utility, they might at least be entertaining to you or other gentlemen, who have been making observations of a similar nature.

During my last voyage I have employed two marine

barometers, one made by TROUGHTON, the other by RAMSDEN, and a thermometer by FRAZER. These were placed exposed to a free current of air in a cabin, where the basons of the barometers were 13 feet above the level of the sea.

The hours at which the heights of the barometers, and thermometers were taken, *viz.* noon, IV hours, X hours, XII hours, XVI hours, and XIX hours, were chosen, because at these times the mercury in the barometer had been perceived to be regularly stationary between the tropics, by former observations made in India in 1800 and 1801. It was found that in settled weather in the Indian seas, from 8 AM to noon, the mercury in the barometer was generally stationary, and at the point of greatest elevation; after noon it began to fall, and continued falling till 4 afternoon, at which time it arrived at the lowest point of depression. From IV or V PM the mercury rose again, and continued rising till about IX or X PM, at which time it had again acquired its greatest point of elevation, and continued stationary nearly till midnight; after which it began to fall, till at IV AM it was again as low as it had been at IV afternoon preceding; but from this time it rose till 7 or 8 o'clock, when it reached the highest point of elevation, and continued stationary till noon.

Thus was the mercury observed to be subject to a regular elevation and depression twice in every 24 hours in settled weather; and the lowest station was observed to be at about 4 o'clock in the morning and evening. I remarked that the mercury never remained long fixed at this low station, but had a regular tendency to rise from thence till towards 8 in the morning and about 9 in the evening, and from those times continued stationary till noon and midnight.

In unsettled blowing weather, especially at Bombay during the rains, these regular ebbings and flowings of the mercury could not be perceived ; but a tendency to them was at sometimes observable when the weather was more settled.

In the sheets, which I formerly presented to you, were evinced these elevations and depressions twice every 24 hours within the tropics, in steady weather, as had been observed by Mess. CASSAN and PEYROUSE, by Dr. BALFOUR of Calcutta, and others. But since my last arrival in India, I have observed that the atmosphere appears to produce a different effect on the barometer at *sea* from what it does on *shore*.

As I am ignorant whether this phenomenon has been noticed by any person before, I will here give you an abstract of my journal, shewing how the barometer has been influenced during the whole time since I left England, which will enable you to form an idea whether I am right in concluding that the barometer is really differently affected at sea from what it is on shore, at those places in India where the observations have been made.

The first sheet begins with the observations made on board ship, in my voyage from London towards Bombay, in the months of April and May, 1802.

From the time of leaving the Land's End, April 19th, the motion of the mercury in barometers was fluctuating and irregular until we were in latitude 26° N, longitude 20° W, on April 29th ; the mercury in barometers then became uniform in performing two elevations and two depressions every 24 hours, (which for brevity in mentioning hereafter I will call equatorial motions.) From latitude 26° N to latitude 10° N, the difference of the high and low stations of the mercury in the

barometers was not so great, as it was from latitude 10° N across the equator, and from thence to latitude 25° S. Within these last-mentioned limits, the difference of high and low stations of the mercury in the barometers was very considerable, generally from five to nine hundred parts of an inch, both in the daily and nightly motions.

When we reached the latitude of 28° S, longitude 27° W, June 7th, the mercury in barometers no longer adhered to the equatropical motions; but then, as in high north latitudes, its rising and falling became irregular and fluctuating during our run from latitude 28° S, longitude 27° W, (mostly between the parallels of 35° and 36° S,) until we were in latitude 27° S, and longitude 51° E, on the 11th of July. The mercury then began to perform the equatropical motions, and continued them uniformly, during our run from the last-mentioned position, up the Madagascar Archipelago, across the Equator, until our arrival at Bombay July 31st, 1802.

August 6th, 1802. When the barometers were placed on shore in Bombay, the mercury, for the first six days, appeared to have a small tendency towards performing the equatropical motions, but not equally perceptible as when at sea, the difference between the high and low stations of the mercury in the barometers being great to the day we entered the harbour of Bombay. From the 12th of August to the 22d the mercury could not in general be observed to have any inclination to perform the equatropical motions, although at times a very small tendency towards performing them might be perceived.

On the 23d of August the barometers were taken from the shore to the ship. Immediately on leaving Bombay harbour, August 26th, 1802, the mercury in the barometers performed

the equatropical motions, and continued them with great uniformity, during our passage down the Malabar coast, across the bay of Bengal, in the Strait of Malacca, and through the China Sea, until our arrival in Canton river on the 4th of October. When in the river, the mercury became nearly stationary during the 24 hours, except a small inclination at times towards the equatropical motions, but they were not near so perceptible as at sea ; this change taking place the day we got into the river.

During our stay in China, the barometer on shore, at Canton, had very little tendency towards the equatropical motions, throughout the months of October and November that we remained there. At times, while in China, a small inclination towards performing the equatropical motions appeared : but, as in Bombay, the difference of rise and fall was of so small a quantity, as to be frequently imperceptible.

December 2d, 1802. On our departure from Canton river, the equatropical motions were instantly performed by the mercury, and with great regularity continued during the whole of the passage to Bombay, until our arrival in that harbour on the 11th of January, 1803.

On January 18th, the barometers were placed on shore, and did not appear in the smallest degree subject to the equatropical motions ; although, with great regularity, they had been performed while at sea, even to the day we entered the harbour. One of the barometers was left on board for a few days, and, like that on shore, seemed to have no tendency towards the equatropical motions. During the months of February and March, in Bombay, the mercury was nearly stationary throughout the 24 hours. But about the latter part of March

the mercury seemed to incline towards the equatropical motions in a very small degree ; and, during the month of April, and to the 20th of May, this small tendency of the mercury to perform the motions appeared at times, but was hardly discernible, the rise and fall being of so small a quantity. From the 18th of January to the 20th of May, the mercury in the barometers was in general stationary, except a very small tendency towards the equatropical motions at times. At other times some change in the atmosphere disturbed the mercury from its stationary position ; but this was seldom the case, as it was then the fair weather season, or north-east monsoon.

We sailed from Bombay on the 23d of May, 1803. The instant we got out of the harbour, the mercury in the barometers conformed to the equatropical motions with great regularity, and the difference between the high and low stations was very considerable during the whole of the passage to China, excepting a few days in the eastern parts of Malacca Strait, where the land lay contiguous on each side of us ; the difference between the high and low stations of the mercury was then not so great as in the open sea. On clearing the Strait, and entering the China Sea, the equatropical motions were performed in greater quantity, and continued regular during our passage up the China Sea, until July 2d, 1803. We then entered Canton river, and the equatropical motions of the mercury in barometers entirely ceased.

From July 8th to September 7th, the barometers were placed on shore in Canton, during which time the mercury appeared to have no tendency towards performing the equatropical motions ; but it inclined to a stationary position, except when influenced by changes of weather. After the barometers were

taken from Canton to the ship, we were four days in getting clear of the river, in which time the mercury inclined to be stationary, excepting that a small inclination towards the equatorial motions seemed to evince itself at times. But no sooner had we cleared Canton river, September 13th, 1803, than the mercury in the barometers began to conform to the equatorial motions, of two elevations and two depressions every 24 hours, at equal intervals of time, (although we were near the land until the 15th September.) And the mercury, with great regularity, continued to perform the equatorial motions, from September 13th, 1803, the day we cleared the river of Canton, until October 13th, when we entered Singapore Strait, excepting a small degree of irregularity, which affected the mercury on the 22d September, when it blew a gale on the coast of Isiompa.

October 13th, 1803. On entering the Strait of Singapore, which is about $3\frac{1}{2}$ leagues wide, the mercury in the barometers was then a little obstructed, and did not perform the equatorial motions, in the same quantity of rise and fall, as when we were in the China Sea. But on the following day, October 14th, when we had passed the narrow part of the Strait, the mercury conformed to those motions with regularity until October 21st, when we arrived in the harbour of Prince of Wales's Island; then a great retardation took place in the equatorial motions; for, during the time the ship remained in the harbour, from October 20th to November 5th, 1803, the mercury in barometers seemed only in a small degree subject to them, the difference between the high and low stations of the mercury, being in general not more than half the quantity, that takes place in the open sea, or at a considerable distance

from land. Where the ship lay at this time in the harbour, the land, on one side, was a full quarter of a mile distant, and on the other side about $1\frac{1}{2}$ mile.

On November 5th, being clear of the harbour of Prince of Wales's Island, the equatropical motions were instantly performed by the mercury, in the usual quantity experienced at sea, which continued with uniformity until December 3d. On this, and the following day, the mercury fell considerably during our passage over the tails of the sands at the entrance of Hoogly river, in latitude $21^{\circ} 06' N$; and on December 5th, the day of the moon's last quarter, a gale of wind commenced from NNE, with much lightning and rain in the night. During the latter part of this day, the mercury began to rise, and there soon followed a change of settled weather. When we were in the lower part of the river, the mercury appeared to conform in a small degree to the equatropical motions; but when well up the river, at Diamond Harbour, the mercury inclined to be nearly stationary during the 24 hours, as has formerly been observed to happen in Canton river, Bombay harbour, &c.

On January 13th, 1804, after we had cleared the river Hoogly, the mercury in the barometers began to perform its motions with uniformity, which continued during the passage to Bombay, until our arrival there on February 12th. The barometers being then placed on shore, the mercury inclined to a stationary position, without evincing any propensity towards the equatropical motions from the 12th to the 18th February, 1804, as has been noticed in the foregoing description, to happen frequently, on entering a harbour from sea.

On February 18th, 1804. The meteorological journal ceases,

at which time it comprises the observations of 22 months, having commenced April 6th, 1802, in Margate Road.

I have taken the liberty of sending you this abstract from the journal, to exhibit the apparent difference of the mercury in the barometer at sea, from what has been observed on shore, at those places mentioned in the preceding description. As I have not seen any account indicating the phenomenon, I thought it might be interesting to you, or other gentlemen of the Royal Society to forward this imperfect abstract, the journal itself being too cumbersome to send home at present. But as I am in expectation of returning to England by the ships from China next season, I hope I shall be enabled to present you with the meteorological sheets alluded to above.

I am, &c.

J. HORSBURGH.

P.S. Since I wrote the foregoing abstract, I have received a letter from my friend Mr. DALRYMPLE, intimating that a copy of the meteorological journal itself would be acceptable, which has induced me to transmit to him the original sheets, with a request to deliver them to you. I regret that I could not find leisure time to make out a fair copy, to have sent to you, in place of the original sheets in their rough state.

Bombay,
June 1st, 1804.